Influence of later exposure to perches and nests on flock level distribution of hens in an aviary system during lay

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ABSTRACT Aviaries provide hens with many resources, but birds must develop motor and cognitive skills to use them properly. Introducing birds to aviaries at older ages has been reported to result in less use of perches, nests, and vertical space, which can reduce productivity and hen welfare. The objectives of this study were to examine (1) how enrichment influenced distribution of hens in the aviary during the day and (2) how enrichment influenced the distribution and roosting substrate of birds at night. Hy-Line W36 pullets were raised in floor pens before moving to laying aviaries (100 hens/aviary unit × 4 units/treatments). Control (CON) pullets were placed into aviaries at 17 wk of age (WOA). Floor (FLR) and enriched (ENR) pullets remained in floor pens until 25 WOA, and ENR birds were provided with perches and nests at 17 WOA. Birds were counted in tiers and litter areas of the aviary at morning, midday and evening at 36 and 54 WOA. Data were analyzed using generalized linear mixed models in R statistical software. At 36 WOA, ENR and CON birds occupied aviary areas at similar rates but differently from FLR birds. For example, in the morning 34% of CON hens and 30% of ENR hens occupied the highest tier compared to 15% of FLR hens ($P < 0.01$). At midday, 57% of CON and 57% of ENR birds were counted in litter compared with 77% of FLR birds ($P < 0.01$). In the evening, CON and ENR hens moved to the top tier of the aviary in greater numbers than FLR hens (22 and 17%, respectively, vs. 7%, $P < 0.01$). At 54 WOA, differences between FLR hens and CON/ENR hens were less pronounced, suggesting FLR hens were adapting to the aviary. Overall, we conclude that birds exposed to aviaries at 25 WOA can adapt to aviary systems, but take more time to do so than birds exposed to aviaries or vertical enrichment at 17 WOA.

Key words: laying hen, aviary, welfare, enrichment, vertical space use

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INTRODUCTION

In response to consumer demands, the North American egg industry is replacing traditional cages for laying hens with non-cage styles of housing, including aviary systems. Aviaries come in many configurations and offer features such as open litter areas, multiple vertical tiers, perches, and nests. In addition to offering more floor space per bird than traditional caged housing, the added features of an aviary are meant to facilitate natural, strongly motivated behaviors in hens including dust bathing (Vestergaard, 1982), roosting (Brendler and Schrader, 2016), perching (Appleby and Duncan, 1989; Newberry et al., 2001), and laying eggs in a nest (Cooper and Appleby, 1995). Facilitating performance of these behaviors is intended to increase hens' welfare while in production (Lay et al., 2011). Aviaries offer food, water, perches, and nests among levels at various heights from the ground; therefore, birds require cognitive and motor spatial skills to navigate through the system (Gunnarsson et al., 2000; Colson et al., 2008). Birds that do not possess these skills may lay more eggs outside of the nest (Gunnarsson et al., 1999), have worse bone strength (Ruth et al., 2000), may move less through the system (Colson et al., 2008), or may suffer injuries when they transition among tiers (Stratmann et al., 2015).

Hens develop spatial skills through practice at a young age (Gunnarsson et al., 2000), and the configuration and enrichment of pullets' rearing environment plays a role in development of hens' behavior as adults (Tahamtani et al., 2015; Hunniford and Widowski, 2016). For example, pullets given access to perches from 0 to 8 WOA were able to jump to higher perches compared to pullets who did not have

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access to perches until after 8 WOA (Gunnarsson et al., 2000). In addition to improving spatial navigation skills, raising hens in enriched environments can also reduce feather pecking (Nørgaard-Nielsen et al., 1993) and fear (Reed et. al., 1993). Hens' ability to adapt to an aviary is thus influenced by rearing environment, and it is recommended that birds be reared in the same environment they are destined for in lay (Colson et al., 2008; Janczak and Riber, 2015). If using a rearing aviary for pullets destined for laying aviaries is not possible, then enriching floor pens with vertical arrays of perches has been recommended as an alternative to help the young birds' spatial development (Colson et al., 2008).

Rearing environments of pullets are therefore important to subsequent adult laying hen behavior, and ensuring that hens are able to access resources in the aviary leads to improved welfare and production. However, previous research examining adaptation of hens to aviaries has focused on (1) impacts resulting from manipulating environments at young ages or (2) only looking at hen responses in the time shortly after introducing hens to laying aviaries. For example, Gunnarsson et al. (2000) found a strong influence of enrichment between 0 and 8 wk of age (WOA) on birds' spatial ability at 16 WOA. Colson et al. (2008) reared pullets in enriched floor pens or rearing aviaries and then studied hens 10 wk after their transfer to laying aviaries; however, they did not report changes over time within that period. Additionally, it is important to observe the behavior of hens further into lay as the incidence of keel bone damage increases with age (Stratmann et al., 2015; Casey-Trott et al., 2017). This could possibly be a result of the onset of osteoporosis at 42 wk of age in laying hens (Sandilands, 2011) or because the keel bone may take up to 40 wk to become fully ossified (Riber et al., 2018).

To the best of our knowledge, no one has looked at developmental plasticity in adult hens, and whether hens are able to gain the spatial skills needed to adapt to aviaries at older ages or amount of time it takes them to do so. Therefore, the purpose of this study was to evaluate the effects of later enrichment on the development of subsequent behavior of the adult laying hens in an aviary system. Our first objective was to observe daytime flock-level distribution of laying hens in aviaries that had remained in floor pens for 25 wk (rather than the more typical 17 wk) and to determine whether enrichment of floor pens with perches and nests mitigated the negative effects of delayed movement into the aviary. A second objective was to conduct a similar examination of hens' nighttime distribution and substrate use in aviaries, again focusing on the effect of moving birds into aviaries at 25 WOA and whether provision of enrichment mitigated negative effects of moving at older ages. We hypothesized that control birds and hens receiving enrichment in floor pens would show similar patterns of distribution throughout the aviary, using upper substrates in patterns similar to previous reports. We also predicted that birds remaining in floor pens without enrichment until 25 WOA would occupy the floor to a greater extent than upper tiers of the aviary.

MATERIALS AND METHODS

Ethics

All research protocols were approved by Michigan State University Institutional Animal Care and Use Committee prior to the start of data collection (AUF# 05/16-071-00).

Pullet Housing and Experimental Design

Hy-Line W36 chicks were raised in 6 floor pens (27.87 m^2/pen, 300 chicks/pen) at the Michigan State University (MSU) Poultry Teaching and Research Center (East Lansing, Michigan). The chicks were brooded on plastic platforms (1.2 m × 4.9 m × 0.46 m), and at 3 WOA ramps were placed to allow birds to access a floor covered with wood shavings. Birds had ad libitum access to food and water throughout the rearing period via 7 feed pans and 22 pin-metered nipple drinkers in each pen. For more detailed information on the management of pullets, please refer to Karcher et al. (2019).

At 17 WOA, pullets in the control group (CON) were moved into Natura60 aviaries (Big Dutchman, Holland, MI) in the MSU Laying Hen Facility (LHF). CON pullets were initially placed into 4 units within a single room (144 birds/unit). Pullets in the enriched treatment (ENR) remained in their rearing pens from 17 to 25 WOA but were provided with wooden perches of varying heights (8.36 cm/per bird) and nests (56.8 cm/hen). Pullets in the floor treatment group (FLR) remained in unaltered rearing pens from 17 to 25 WOA. At 25 WOA, ENR and FLR pullets were moved into aviary units in the LHF. At this time, hens of all treatments, including CON birds, were distributed among 4 rooms so that each room housed 1 unit of each treatment (for a total 4 units/treatment). Across the rooms, each treatment occupied different locations within the row of units (i.e., closest to door, furthest from door, etc.) to avoid any confounding effect between unit location and treatment effects. Due to euthanasia for tissue sampling as part of another project, natural mortality and incidental bird movement between pens, at the start of the current study the number of birds in each pen ranged from 89 to 102.

Layer Housing and Data Collection

Each aviary unit contained 3 vertical tiers and an open litter area (Figure 1). Metal perches (244 cm long, 3.1 cm diameter) were arranged within each of the aviary tiers. The top tier contained a colony nest (122 × 52 cm), which closed 2 h before lights off and re-opened

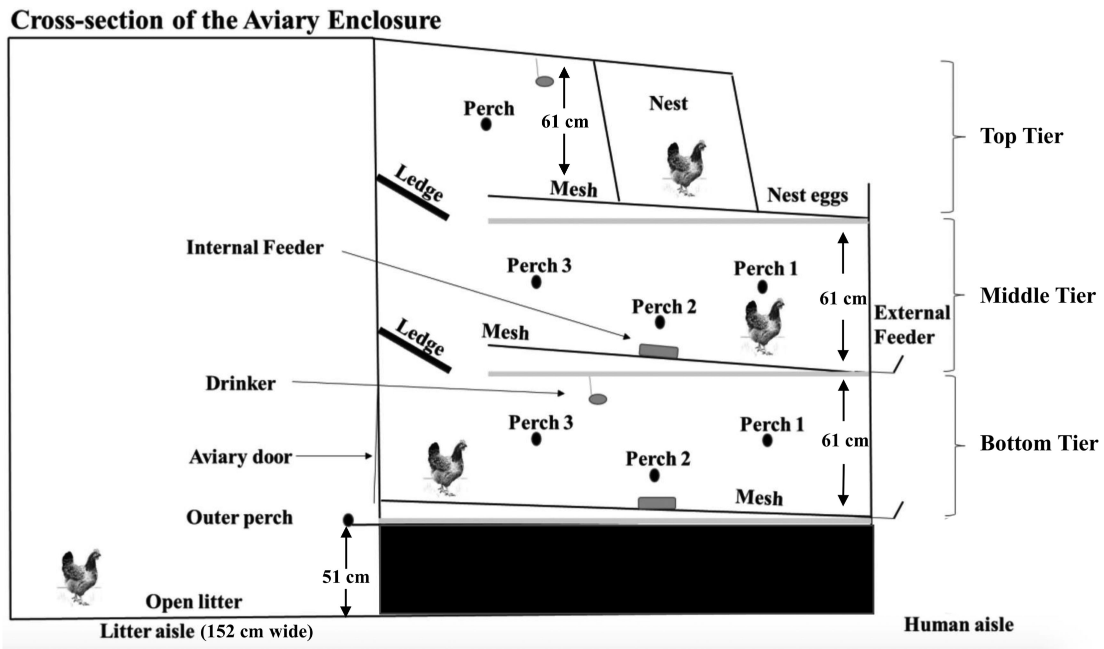

Figure 1. Cross-section of the aviary used in the study, showing the litter aisle and human aisle, vertical tiers, wire floor, edges, ledges, colony nest, and litter area. The length of each unit was 244 cm. The widths of the wire floors in each tier were as follows: bottom tier = 150 cm, middle tier = 127 cm, and top tier = 43 cm. The nest was 52 cm wide. Adapted from Ali et al. (2016).

when lights came on the next morning. Each aviary unit also included solid metal ledges (244 × 33 cm) to help hens transition among tiers (Figure 1). Hens were enclosed in the tiered portion of the aviary for 24 h after placement but thereafter had continuous access to the litter with 1,629.7 cm^2 of space per bird. For a more detailed description of the housing system and management protocols, please refer to Ali et al. (2016).

Direct observations of hens' distribution at the flock level were conducted over 3 consecutive days at 36 and 54 WOA. Observations captured hens' distribution inside the tiers of the aviary and on the litter during the day (lights on) and night (lights off). Morning observations were conducted from 08:00 to 10:00, midday observations from 12:00 to 14:00, and evening observations from 18:00 to 20:00. Dark observations were conducted 30 min after light out (21:00–23:00), and again 2 h before lights on (04:00–06:00). Three trained observers, working in pairs, collected data simultaneously, and inter-observer agreement was found to be very good (Kappa = 0.96, $p < 0.001$; CI = 0.90, 0.99). The order in which data were collected from units and rooms was stratified across the 3 days of observation for each time of day (morning, midday, evening, and dark) at each age (36 and 54 WOA). Counts of birds were simultaneously made from both sides of the enclosure (i.e., human and litter aisles, with 1 observer on either side). At each time of day, 2 rounds of observations were made for each pen with the second round made about 1 h after the first once all units had been observed. Each observer counted the number of birds per substrate (perch, ledge, wire mesh floor) in each tier of the aviary. The observer in the litter aisle also counted the number of hens on the litter and in the nest. At night, the observer in the human aisle used a ladder to gain enough height to look down over the nest into the top tier to count the birds occupying the top tier from above.

To avoid disturbing the hens, observers entered the room quietly and moved slowly to minimize noise and motion. The observer counting hens from the litter aisle stood outside the unit being observed (either at the end of the row, or in the litter area of an adjacent unit that had already been observed). At night, observers used green headlamps to see the birds rather than turning on system lights. Green headlamps have been used successfully in previous studies, with birds showing no movement in response to the green light (Campbell et al., 2016). Observations during the day were never conducted when the feed belt was running. Anecdotally, no large-scale movements of hens between levels or substrates were noted when observers used these precautions.

Statistical Analysis

The number of birds counted in each area/substrate at each observation was converted to a percentage based on the total number of birds in that unit. This conversion was necessary because the number of hens in each unit was not uniform. Statistical analysis was conducted using R software (3.2.2), package "lme4" (R Core Team, 2013) and a significance level was set at $\alpha = 0.05$. Visual examination of density and QQ plots indicated that data (which were counts) approximated a normal distribution.

For daytime data, hen percentages were compared among treatments and time of day within ages and tier of the aviary. To describe the influence of enrichment on hens' distribution and any interactions, a generalized linear mixed model (GLMM) was developed and assigned to the family "poisson" (to accommodate count rather than continuous data) using the "lme4" package in R. Time (morning, midday, evening), treatment (CON, ENR, FLR), and age (36 and 54 WOA) within each tier of the aviary were considered main effects and were analyzed for all interactions, while day and unit were included as random effects. The data were further analyzed using Tukey's honestly significant difference test (HSD) for multiple pairwise comparisons using the "multcomp" package in R.

For nighttime data, a GLMM was used to compare treatments within different substrates of the highest tier (wire mesh floor, perch, ledge, edge) and to compare distribution of hens by treatment within tiers of the aviary (litter, bottom, middle, and top). Time was removed from the model, after using an ANOVA to determine that hens' distribution was not different between the two observations conducted at night.

RESULTS

Distribution of Hens during the Light Period

During the light period, the percentage of hens on the litter, bottom, middle, and top tier was affected by interactions between time and treatment (litter: Z = 9.786, $P < 0.001$; bottom tier: Z = –24.566, $P < 0.001$; middle tier: Z = –31.078, $P < 0.001$; and top tier: Z = –31.931, $P < 0.001$). During the morning at 36 WOA (Figure 2a), the CON and ENR birds distributed among the tiers of the aviary similarly, with more hens in the middle tier ($P < 0.001$) and the top tier ($P < 0.001$) compared to FLR birds. Conversely, more FLR birds were observed in the litter ($P < 0.001$) and in bottom tier ($P < 0.001$) compared to CON and ENR hens. During the midday at 36 WOA (Figure 2b), for all treatments most birds were counted in the litter, with a greater percentage of FLR birds observed there compared to CON and ENR ($P < 0.001$). No treatment differences were seen in bottom- or top-tier occupancy; however, more CON and ENR birds were found in the middle tier relative to FLR birds in midday at 36 WOA ($P < 0.001$). At 36 WOA in the evening (Figure 2c), the majority of birds were again counted on the litter for all treatments, with more FLR birds on the litter than ENR birds ($P < 0.001$). More CON and ENR birds were counted in the middle ($P < 0.001$) and top tiers ($P < 0.001$, $P = 0.002$) than FLR birds; however, more ENR and FLR birds than CON birds were counted on the bottom tier ($P = 0.002$, $P < 0.001$, respectively).

In the morning at 54 WOA (Figure 2d), more CON and ENR birds were counted in middle and top tiers compared to FLR birds ($P < 0.001$). More FLR birds were again observed in the bottom tier as well; however, there was no longer a treatment difference related to percentage of birds on the litter. In the midday at 54 WOA (Figure 2e), most birds were still counted on the litter; however, the differences between treatments were no longer present. In the evening at 54 WOA (Figure 2f), treatment differences were still evident in the middle and top tiers, with more CON and ENR birds in these areas than FLR birds ($P = 0.019$, $P = 0.001$, respectively). However, compared to 36 WOA there were greater percentages of FLR birds now in higher tiers. Also in the evening at 54 WOA, more CON birds were counted in the bottom tier than in the evening at 36 WOA ($P = 0.008$).

At 36 WOA, CON and ENR hens laid fewer eggs on litter than FLR hens (19.35 and 26.43%, respectively vs. 51.06%; $P < 0.01$). At 54 WOA, the difference in floor laying between FLR and CON/ENR hens was less pronounced (CON: 6.91%, ENR: 8.75%, FLR: 23.39; $P < 0.01$).

Overall, CON and ENR hens distributed themselves similarly throughout the aviary and differently from FLR hens. At 54 WOA, these patterns did not fundamentally change, but the magnitude of difference between FLR and the other 2 treatments became less pronounced. The distribution of CON birds generally did not change between 36 and 54 WOA, suggesting that these birds, which had moved into the aviary at 17 WOA, had adapted by 36 WOA. However, in the period between 36 and 54 WOA, the ENR and FLR birds' distribution continued to become more similar to that of CON birds.

Distribution of Hens in the Dark Period

At 36 WOA in the dark period (Figure 3a), more CON and ENR birds were observed in the top tier ($P < 0.001$), while more FLR birds were counted in the bottom tier ($P < 0.001$). While large percentages of birds from all treatments were observed in the middle tier, a higher percentage of FLR birds occupied this tier compared to CON and ENR birds ($P = 0.010$, $P = 0.022$, respectively). When looking at hens' occupancy of specific substrates within the aviary at night (Figure 3b), differences were observed among the 3 treatments. The CON hens occupied the ledges in the largest percentages ($P < 0.001$), more ENR birds occupied perches than hens in the other 2 treatments ($P < 0.001$), and more FLR birds were counted on the wire mesh floors ($P < 0.001$). At 54 WOA, the birds' nighttime pattern of distribution through the tiers of the aviary (Figure 3c) was largely similar to those seen at 36 WOA; however, more FLR birds were counted in the top tier at 54 WOA compared to 36 WOA ($P = 0.035$). Similarly, between 36 and 54 WOA, the percentage of birds of each treatment group roosting on the various types of substrate did not change (Figure 3d), but differences were not as dramatic as those seen at 36 WOA. Thus, over time ENR birds' nighttime pattern of distribution became more similar to that of the CON birds. However, CON birds were still observed in higher percentages on ledges at night while ENR hens were found in higher

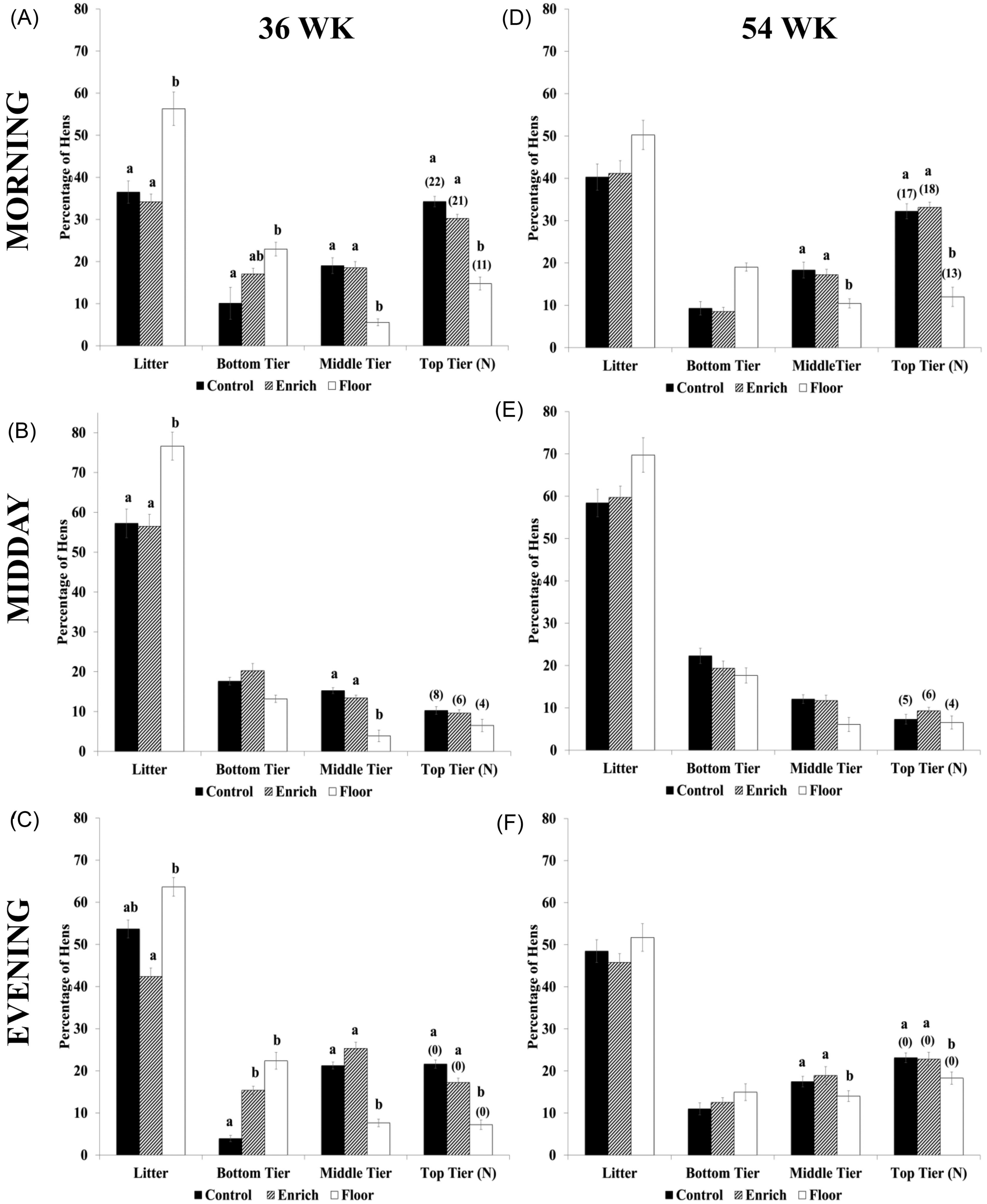

Figure 2. Percentage of hens in each treatment counted in different areas of the aviary (litter, bottom, middle and top including the nest, with number of birds in the nest shown in parentheses above the bar in the graph) in the day time during 36 wk of age (WOA) in (a) the morning, (b) midday, and (c) evening and during 54 WOA in (d) the morning, (e) midday and (f) evening. All parameters are expressed as average percentage of hens ± SEM. Different superscripts indicate differences among treatments in a location ($P < 0.05$).

percentages on highest perch. While FLR birds continued to occupy the wire mesh floor in the largest percentages, higher percentages of FLR birds were counted on perches and ledges at 54 WOA compared to 36 WOA ($P = 0.041$, $P = 0.033$, respectively).

DISCUSSION

Our first objective was to observe daytime flock-level distribution of laying hens in aviaries that had remained in floor pens until 25 WOA (beyond the typical

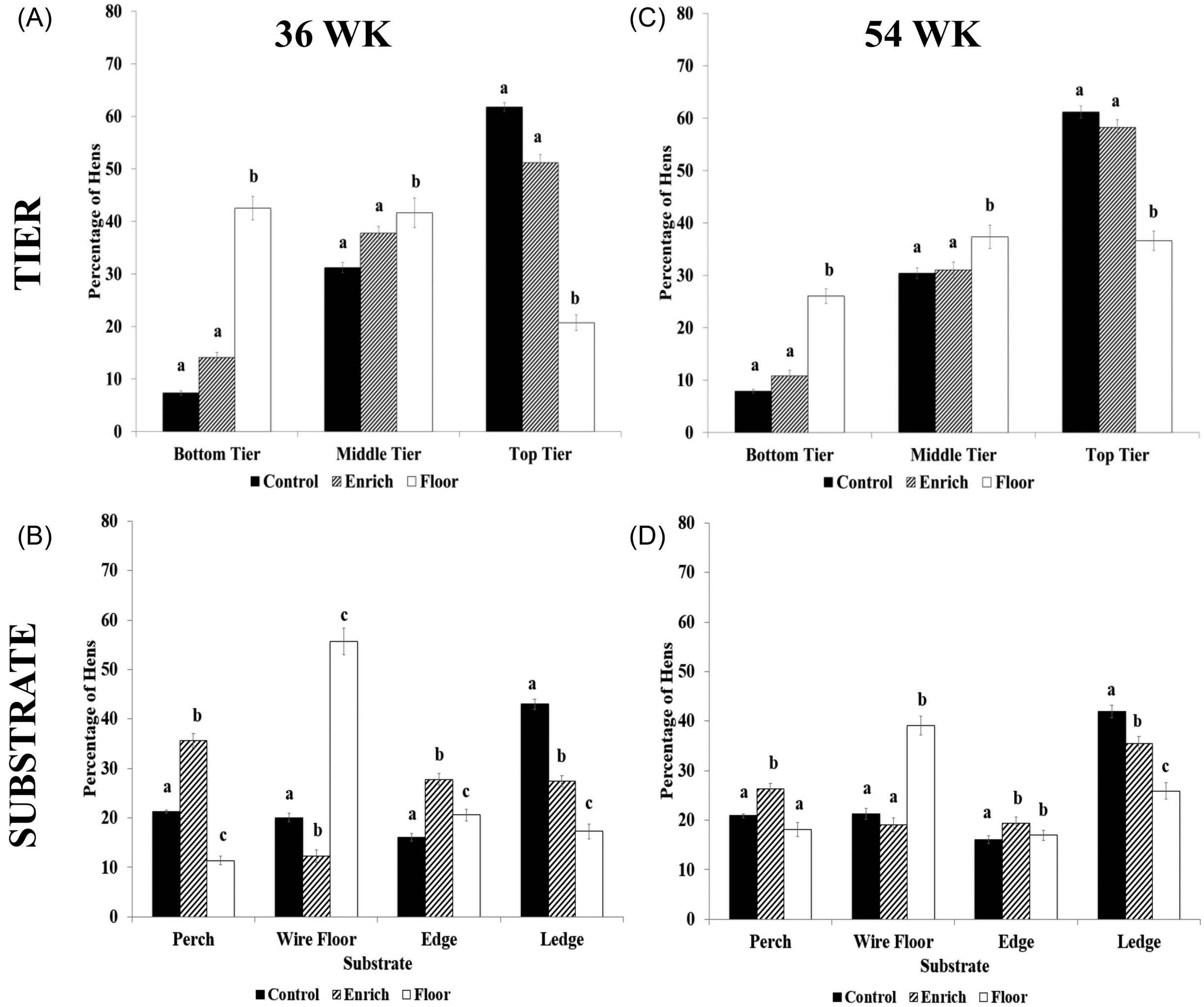

Figure 3. Percentage of hens counted in each tier of the aviary (bottom, middle, and top) during the dark period at (a) 36 wk of age (WOA) and (c) 54 WOA and percentages of hens counted roosting on different substrates (perch, wire mesh, ledge, edge) at (b) 36 WOA and (d) 54 WOA. All parameters are expressed as average percentage of hens ± SEM. Different superscripts indicate differences among treatments in a location ($P < 0.05$).

17-wk rearing period) to determine whether enrichment of floor pens with perches and nests mitigated the effects of delaying their introduction to laying aviaries. A second objective focused on hens' nighttime distribution and use of various roosting sites in response to moving to aviaries at 25 WOA, with and without prior exposure to perches and nests enrichment in pullet floor pens, on hens' distribution use of various types of roosting sites. We hypothesized that CON and ENR hens would have similar distributions and would occupy higher tiers, perches, and ledges of the aviary to a greater extent compared to FLR hens. We also predicted that FLR birds would utilize the litter and bottom tier in the largest numbers.

Distribution of Hens during the Light Period

In the morning and evening at 36 WOA CON and ENR hens were spread through the system while FLR hens were almost exclusively on the litter during these times. Birds have developmentally sensitive periods and are better able to learn certain skills if exposed to them at particular times (Blackmoore and Cooper, 1970; Bateson, 1979; Gunnarsson et al., 2000). Previous studies have demonstrated the importance of the early rearing environment on subsequent behavior of adult hens. For example, birds reared with perches from day 1 of age were able to obtain a food reward by jumping to perches at various heights while birds given access to perches at 8 WOA were not able to perform this task as well (Gunnarsson et al., 2000). Birds reared in more complex environments also used higher tiers more than those reared in barren environments and make more accurate flights and jumps between as they navigate (Colson et al., 2008). However, to date no one has looked further into the lay cycle to understand how long it may take hens to fully adapt to aviaries if not provided with perches or rearing aviaries as pullets. In our study, CON and ENR birds may have been more comfortable navigating the tiers of the aviary because they were introduced to the aviary or vertical arrays of perches and nests at 17 WOA. However, the FLR birds were not introduced to any vertical structures until they were 25 WOA which could hinder the birds' physical ability to navigate the aviary, the birds' mental perceptions of the aviary, or possibly both. A large change in environment, such as moving from floor pens to an aviary, can cause fear in laying hens (Jones, 1982), and enrichment has been shown to reduce in fear of birds if they are exposed at hatch (Jones, 1982; Reed et al., 1993). Thus, it is possible that any exposure to aviaries or perches before 25 WOA reduced fear in CON and ENR birds, and this may have led them to explore and use all levels of the aviary to a greater extent. Based on our findings, laying hens appear have a sensitive period to novel objects and/or environments that lasts until after 17 WOA; the FLR birds demonstrate that some behavioral plasticity persists even after 36 WOA. Their patterns of distribution in the aviary changed from 25 to 54 WOA, but the change was slow and incomplete.

In addition to these overall trends, we also saw more subtle patterns in distribution of birds among treatments and ages. In the morning at 36 WOA, we recorded twice as many CON and ENR birds in nests compared to FLR birds, but at 54 WOA we saw more FLR birds in the nest. These patterns are also reflected in the number of mislaid eggs from each treatment as CON and ENR laid fewer eggs outside the nest compared to FLR birds at 36 WOA, but this disparity decreased by 54 WOA. In the evening at 36 WOA, fewer ENR birds occupied the litter area and more were observed in the bottom and middle tiers. This suggests that ENR birds started to move into the aviary for the night earlier than hens in the other treatments, as earlier in the day ENR birds were present on the litters in the same numbers as CON hens.

Previously, the distribution of aviary-reared hens was found to be different than that of cage-reared hens (Branstaeter et al., 2016), with aviary-reared hens spending more time on perches and the platform and flying more when startled at 19 WOA compared to cage-reared birds. However by 23 WOA, these differences were no longer present (Branstaeter et al., 2016). Wichman et al. (2007) found that chicks reared with perches had better spatial ability than those reared without, but this difference was only detectable when the perching task was difficult and the environment was novel. Practice helped the birds to overcome the differences in their rearing environments (Wichman et al., 2007). These findings were also demonstrated by the decrease in treatment differences between birds in the present study at 36 and 54 WOA. While we found similar results to previously conducted studies, this study reared birds in the same way, i.e., in floor pens with no enrichment until 17 WOA. Therefore, any of the differences we see between treatments developed after the birds were 17 WOA. This suggests that the birds in this study were able to learn and adapt to new environments even at older ages.

Distribution of Hens during the Dark Period

At night during 36 and 54 WOA, CON and ENR birds were found in larger percentages on the higher aviary tiers (middle and top) while FLR birds were most numerous in the bottom tier. Interestingly, hens from the 3 treatments also differed in substrates upon which they roosted overnight. More ENR hens were found on perches and edges, suggesting a preference for grasping while resting. Pullets and hens are highly motivated to perch (Newberry et al., 2001; Olsson and Keeling, 2002; Heikkila et al., 2006), and perching behavior in adulthood is influenced by the availability of perches during rearing (Faure and Jones 1982; Appleby et al., 1983). Perhaps the ENR birds in our study preferred to roost on perches and edges (on both of which hens use the same grasping foot position) more than FLR birds because they were exposed to vertical perch arrays at 17 wk in their floor pens while FLR birds were not.

The CON hens occupied all the substrates found in the aviary and were found on the ledges in larger percentages than birds of other treatments during both periods of lay. Their pattern of distribution among tiers and roosting substrates seem to suggest they prefer overall height to a specific substrate. White strains of birds have previously been found to prefer height over graspable perches to roost on at night (Muller and Schrader 2009), and CON birds in our study seem to be exhibiting this preference by resting on ledges which have height, but are not graspable like perches. In contrast, ENR birds were found in larger percentages than CON and FLR on perches. This could be due to a combination of natural instinct and being exposed to perch arrays before being moved into the aviary. Thus, the ENR birds may have had a stronger preference for perching than the CON birds because they were exposed to them in their floor pens, before being moved to a novel environment. In comparison, the CON birds' first experience with both perches and vertical space was in a new and novel environment, the aviary, at a relatively old age (17 WOA). Because FLR birds were not exposed to perches before 25 WOA, they did not have the opportunity to learn to use perches until later than the other 2 groups. Late access to perches during rearing results in less perching behavior of adult hens, and adult hens with no access to perches during rearing do not perch as adults (Fauer and Jones, 1982; Appleby et al., 1983; Appleby, 2007) possibly due to the lack of cognitive skills allowing them to recognize the perch as a structure that can be used (Gunnarsson et al., 2000). FLR hens were also observed mainly in the bottom and middle tiers at 36 WOA, suggesting that they did not have either the spatial skills or the desire to occupy the top tier to the extent the CON and ENR birds did.

Limitations

One main limitation of this study was that we were not able to observe the birds prior to 36 WOA, as they were part of another study. Thus, while treatment differences were still apparent between FLR hens and those in CON and ENR, studying hens before this point would provide an understanding of the initial magnitude of differences among treatments and initial changes occurring when hens were first introduced to aviaries, perches and nests. Additionally, while we observed behavior in response to provision of nests and perches, we cannot draw conclusion about underlying mechanisms. Future studies could examine corresponding changes in hens' physiology and neurobiology, examine specific bird behaviors such as aggression and feather pecking, or take measures of bone strength and keel bone damage.

CONCLUSIONS

Enriching floor pens with perches and nest boxes affected adult hens' spatial distribution when they were subsequently placed in an aviary system. Birds who moved into the aviary at 25 WOA but received enrichment (ENR) were not found to behave differently than CON birds who moved into aviaries at 17 WOA. Birds who were moved into the aviary at 25 WOA but did not receive enrichment in floor pens (FLR) did not occupy upper tiers of the aviary to the same degree as birds in the other treatments and took at least 20 wk to adapt to the system. These findings suggest that providing birds with enrichment such as perches and nests in their floor pens can be beneficial for their transition to an aviary system, even if provided at older ages. Producers can use these findings to improve rearing in floor pens or in situations where placement of hens into aviaries is delayed.

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